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TABES PULMONUM.

—OR—

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By the term Tabes Pulmonum, the entire range of pulmonic disintegrations is included, whether they be the consequence of lymphoid deposit, and subsequent caseous morphology, or result from the irritation induced by tubereular deposit in the pulmonary parenchyma. This inclusive term seems to be demanded by the present position of pathological science. Recent investigations confirm the views of Addison, that tubercle is often absent in the most rapid and extensive disintegrations, and that even when extensively present would possess but slight importanee did they not, by the irritation they induce, awaken a low disorganizing form of inflammation which involves the pulmonary tissue, and damages beyond repair and restoration the respiratary apparatus. Tubercle, however, does play a very important part in the role of phthisis,

in fact, constitutes by far the greater source of tabes pulmonum. Virchow and Niemeyer and Addison, in the enthusiasm of a new disclosed fact, have led the medical world to ignore too largely the favorably accepted opinions of Louis, and to attribute all pneumonic lesions, tubercle included, to inflammatory ulceration. Admitting, as we must, that cut sections of bronchial tubes, thickened, softened, dilated, and containing in their cavity mueo-purulent fluid, have been mistaken for tubercle; as also lung tissue which, by the proeess of inflammation, had become hepatized and assumed the granular form and appearanee, have led to equally erroneous conelusions; it is not less true that these voyagers into the hitherto unexplored seas of pathological science have eommitted even graver errors in ignoring the tubereular origin of vast vomicæ, because tubercles are not found in the residue of the pulmonary tissue, forgetting as they do, that even a large deposit may have been excavated and removed with the missing lung parenchyma. On the other hand it may be as surely admitted, that even when a moderate tubercular deposit is present, that it may exist as a coincident—an unimportant companion of a rapid case of pneumonie phthisis—or more properly speaking, scrofulous pneumonia. It may be then aecurately stated that scrofulous pneumonia is not dependent upon tubercle or even a tubercular diathesis for its origin, progress, or consequences, and may run either a rapid or tardy course, innocent of any assistance from tubercle, demolishing lung structure until it is inadequate for the purposes of life, while on the other hand it is possible that tubercles may be extensively deposited, oeeupy a large portion of the lungs, and yet awaken tubercular pneumonia. In this case however, the tubercle undergoes an oily metamorphosis, the fatty elements are absorbed, and calcareous bodies left in the lungs, and whieh may be and often are expectorated. Unfortunately however, this is not the usual result. The irritation the deposit exeites, awakens a low, disorganizing form of inflammation, —tubercular pneumonia—generally terminating in death. From this view we are brought to the consideration of two very fatal maladies, separate in their origin, different in their course, yet having several points of resemblance which have heretofore caused them to be regarded as but modifications of a single lesion, the consequent of a single cause, and to be embraeed under a common name, phthisis pneumonia. I believe this error has been an impediment to the attainment of correct pathological deductions,

and the judicious application of remedial agents. One disease is a modified plegmasia, closely allied in its nature to a continued fever, while the other is a zymotic poison, in some yet unexplained manner developed in abnormal nutrition, and assimulating septicœmia in its pathology. To draw the distinction between these, to give each its position and assign to each an unobjectionable name, is the purpose of this paper.

Scrofulous Pneumonia.—In 1858, when I wrote my thesis for the Faculty of the University of New York, this was regarded as being even of doubtful existence; then the microscope had scarcely been called to the aid of the pathologist, and the non-inflammatory views of Louis controlled the opinion of both English and American physicians with a very few exceptions. Dr. Martyn Paine, of the University of New York, ever maintained ultra views in the opposite direction and scarcely drew a line of distinction betweeir tuberculous and plegmasia. The influence of his teachings led me to investigate the phenomena presented in diseases involving destruction of the respiratory apparatus, both clinically and miscroscopically, to ascertain wherein Dr. Paine was correct, and wherein Lænnec and Louis and their followers erred. In the dead-house I found many labelled phthisis, in whom I failed to detect a tubercle, notwithstanding extensive vomicæ were present. In such cases, I also noticed that the pulmonary disorganization resembled more closely the consequences of inflammation than that presented when tubercle was found. Other organs of the body also, it seemed to me, presented different classes of lesions. The mucus membranes exhibited more extensive ulceration and had departed with their vital continuity in a much more obvious manner in the non-tubercular. In studying the history of the progress of both classes, those which were tubercular and those that were non-tubercular, I found both equally liable to assume either a rapid or a chronic type. A very large per cent. of the non-tubercular cases seemed even more intimately associated with the scrofulous diathesis than the other—many having suffered in early life from the consequences of glandular swellings, inflammations and ulcerations. The pneumonic trouble could also be generally traced to its origin in a catarrh, bronchitis, or a pneumonia, which was either neglected, or run on in defiance of treatment into the scrofulous form of chronic pneumonia, with extensive pulmonary disorganization. And I also met with mixed cases, whose history led

me to infer that an autopsy would reveal no trace of tubercle; yet upon examination they were found occupying quite extensively the alveoli. It however may be in such cases that tubercles were present even before the advent of the pneumonia, and merely constituted an unrelated complication, but I always deemed it probable that the consequences of pulmonary disintegration assisted in inducing the faults in the digestive and assimilative functions, which I will hereafter show to be directly concerned in the development of tubercle, and acted at least as a concurrent cause in awakening into activity the dormant germ, nurturing its growth and assisting its development. And again, the irritation induced by tubercle was found to have caused extensive inflammation, hepatization, tyrosis and tissue disorganization, but the history of these cases differed, a dry hacking cough, burning in the palms of the hands, with a slight elevation of the temperature, had in every case preceded the eruption of the pneumonic inflammation. A very large per cent. however had began so insidiously that it was difficult to trace them back to the initial lesion—the deposit had taken place, and a large portion of the lung damaged, without a decided manifestation of the mischief then in progress. I have been frequently astonished at the very slight observable evidence in the general symptoms of so important abeyance of a very important vital organ. It thus seems that tubercles are not really so formidable in the injuries they directly inflict by intrusion into the lung parenchyma, as in the irritation their presence induces and the inflammatory processes which follow in the result. These observations led me to divide phthisis pulmonalis into tubercular phthisis and pneumonic phthisis. Although having many characters in common they presented others so diverse that I cannot any longer regard them as the emenations from a single, cause or consequences sufficiently identical to justify a common appellation. In fact, the variations are sufficiently obvious to enable the physician to recognize one from the other.

The precise manner in which tubercle originates—the initial lesion—and the successive links of the chain of causation, is yet a vexed question, inducing various theories and leading to much theoretical discussion. Churchill, of Paris, advanced the theory that tubercle originated in a deficiency of phosphorus in the system in an oxidizable form, and basing his treatment on this hypothesis, proclaimed with much confidence that he had discovered an unerring

specific in the hypophosphites of lime and soda. Unfortunately for his theory, the remedies based upon it abjectly failed to sustain his confident assertions, although proving to be of exceeding value in conjunction with cod liver oil in retarding the succession of morbid phenomena. Dobell imagined that he had discovered the fountain head of this stream of death in deficiency of pancreatic juice, by which the fatty and oily elements were imperfectly emulsified, and consequently not sufficiently elaborated for the purposes they subserve in the animal economy; of which the maintainance of animal heat is no doubt a prominent one—that owing to this deficiency of pancreatic juice and the mal-assimilation of the fatty elements of the food, adipose tissue is consumed as a source of caloric, and the blood altered in its constituents, contains an excess of modified albuminous agents, which being imperfectly vitalized, exudes into the pulmonary parenchyma and eventuates in the morbid body we term tubercle. In order to remedy this he administered pancreatic juice artificially obtained from animals and emulsioned, hoping to thus contribute the required agent and remedy the lesions emenating from the deficiency. But with Dobell, as with Churchill, he had only recognized an effect, while the above, the real cause, remained as yet beyond human ken. John Hughes Bennett, of Edinburg, among other valuable suggestions, called the attention of the profession to an excessive amount of acid in the small intestines as one of the conditions of tuberculosis. Buhl attributed tubercle to the development of a peculiar tuberculous virus, generated in the caseous metamorphosis of the albuminous exudation into the lung tissue, generated in a somewhat similar manner to the poison of septicæmia, from a suppurating abscess or stump of an amputated limb. Copland with his great philosophic mind and vast experience, attributed its origin to inefficiency of the organic nervous system, and viewed the immediate consequence of this aberration to faulty digestion and imperfect assimilation. Lænnec and Louis layed the blame on what they termed a tuberculous diathesis, and ignored entirely the influence of catarrhs and inflammations. Virchow on the other hand, regarded tubercle as inseparable from inflammation—in fact a mere coincident which may happen during pulmonic disintegration, and Niemeyer expresses his pathological convictions in saying that "the worst thing that can happen to a phthisical patient is the development of tubercle."

Churchill, Dobell, Bennett, Copland, Lænnec and Louis, each recognized consequences, and these consequences woven together form, as far as they go, a web of truth, but each considered individually fails to give us enlightened scientific and practical views of the lesion, or suggest a course of treatment adequate to its removal. Virchow and Niemeyer seem to found their entire pathological belief on what they had observed in caseous or scrofulous pneumonia, and is erroneous in relation to the true tubercular form of phthisis.

I have observed, that in a very large portion of cases, the very first manifest aberration is derangement of the functions of digestion. In some the stomach is in fault and the usual train of symptoms of dyspepsia are evinced; the desire for food is in an important degree impaired, and ordinary articles of diet are not well tolerated; but in much the larger portion the appetite is good, and all substances that are not of a fatty nature are digested without inconvenience, in fact the gastric digestion in many cases rather exceeded than fell below the normal standard, but the lesion noticed by Dobell is however more uniform; fatty articles of food and oils are nauseous, often loathsome, and in addition to the repugnance they generate, they also cause disagreeable eructations, pyrosis, generally pain in the duodenum and sometimes diarrhœa; attendant upon this, the tissues shrink, the eyes settle in their socket, and evidences of general malaise, give the first admonition of the worm which is withering the very bud of existence. But notwithstanding, we perceive the first lesion in the digestive functions—discover the fault to be as stated by Dobell—deficiency of pancreatic secretion inadequate for emulsion of the fatty elements of the food in a very large number of cases; it is by no means a universal and inseparable one. With many no inconvenience is experienced in either eating or digesting oils and fats; neither is there any marked evidence of defective nutrition long after the lungs are stuffed with tubercles, proving conclusively that the often observed pancreatic lesion is not autotoles, in itself sufficient to produce all the prodroma which originate in and follow tubercle through its various stages of development and disintegration. Dobell, while reconnoitering in the proper direction, has but reached an outpost angle in the line of tubercular processes, has reached a consequence rather than a cause.

Copland's view takes in a much larger field, in fact embraces the

immediate power which presides over the functions of both the thoracic and chylopoitic viscera, while Churchill, looking to the very fountain head of life, the cerebro-spinal nerve system, sought the cause in the deficiency of an element occupying an important relation to nerve function. It may however, be seriously queried: Why comes the deficiency of phosphorous, and it may also be added, hypophosphorous acid in combination with fats, or how it comes to pass that the organic nervous system is recreant to its duty? It cannot be that either phosphorous, or hypophosphorous acid and phosphoric acid are not sufficiently present in the food the consumptive eats, or the water he drinks. Such an idea is set at naught by the fact that the phosphates are exceedingly abundant in the urine, implying a more probable lesion in the phosphatic eliminating function than in the phosphorus assimilating function, and in addition to this we also find quite frequently oxalic acid in the urine. When we take into account the great value of nitrogenous elements of food—how indispensable they are to health and even to the sustenance of life itself, it seems natural to me to link the presence of this oxalic acid with the first prime origin of tuberculosis. Its frequent absence however, denies its original authorship and consigns it to the position of an effect, not a source. It points to some chemical process wrought in the system between glucose and some nitrogenous principle, but where or in what manner I have never been able to determine. We only know such is the case, and that phthisical patients thus producing oxalic acid in the urine are especially benefitted by nitric acid, in fact more than by any other known agent. This may give some coloring the hyper-oxidation theory, but it is more rational to attribute the formation of oxalic acid to some unrecognized aberration in the digestive and asimilative function. And so we can also seek the cause of the deficiency of phosphorus and hypo-phosphorous acid in combination with glycerine and fats. It is well-known that the functions of digestion, assimilation and sanguification are under the control of the organic nervous system, and that furthermore, the portion of the organic nervous system which is immediately concerned in these processes is connected with the cerebro-spinal nerve system—forming the excito-secretory nerve system, which is indeed the field-marshal in the direction of the duties performed by the various vital organs. But every animal phenomena is under the dominion of the brain, every organ, tissue and cell is modified

by its influence. The mysterious, electric-like current it sends forth impresses both normal and abnormal conditions. Every passion, every desire, every emotion, every joy, and every grief is a factor of health or disease. Joy, hope, ambition and success heighten the vital standard, they invigorate every organic function, send the blood with an accelerated pace through the veins and arteries, bearing the elements of cell growth vivified to the highest degree—the digestive, assimilating and sanguifaciant functions are stimulated to new vigor and performed with efficiency, health is exhalted where it already exists, and every constitutional predisposition held in abeyance, while on the reverse, grief and depressing passions and emotions equally lower the vital standard and awaken already existing diathesis. In accordance with this law, we find mental influences playing prominent parts in the dramas of health and disease. Depressing emotions act directly upon the respiratory apparatus, they seem to draw off the nerve stimuli which control the expansion and contraction of the thorax in inspiration and expiration, and induce a quiescence in the circulation of the upper lobe, which may directly lead to tubercular deposit, if the other circumstances and conditions be present.

Although I have never seen this point referred too, I have frequently observed it and believe it contributes an important part in determining the depressing influences to localize their consequences in the lungs. The medulla oblongata is however the vital knot—the throne of life—the fountain of all its phenomena. The entire dominion of organic and animal processes are subservient to its authority, and yield obedience to its mandates. If it be a feeble monarch, confusion and corruption will enter its empire, external and internal foes will conspire against it, its subaltern officers will be recreant to their duty, and the embattlements of health will be stormed and carried by morbific agencies. This is precisely what we witness in tubercular phthisis. The influence of the vital principle is not efficiently given—the organic nervous system is not supplied with its functional power, and the consequences of this inefficiency is evinced in all the organs and tissues over which it wields control. The strumous dyspepsia so fully described by Clark; the pancreatic deficiency of Dobell; the derangement of the organic nervous system of Copland; Parola's theory of imperfect functions of the lung insufficiently compensated for by the function of the liver; the acidity of the intestinal canal and modi-

fied relations of the fats, oils and albumen described by Bennett, are each and all but manifestations of defective life force, and developed by aberrations resulting from depressed nerve power. Churchill recognized a consequence closely connected with the cause in its own defect. I believe there is much truth in Churchill's theory, and probably more in the one I wrought out fourteen years ago (1857), that the earliest departure from health consists in some unascertained modifications of the oxydes of phosphorus in the system, both as to quality and quantity, interfering with the part they play in vital processes, especially as factors of nutrition and assimilators of oxygen. In claiming for phosphorus, in its various formulas an important relation in the origin and development of tuberculosis, it seems to me that the importance of the subject justifies me in entering into a somewhat detailed consideration of the relations these sustain to—life, health and disease—their importance to vital vigor on the one hand, and the deleterious consequences of their deficiency on the other.

In fact, without a brief resumé of the relation sustained by the phosphoids to the functions of nutrition, as well as those which appertain especially to the nerve masses, the connective chain between the deficiency of the phosphoids and pulmonary consumption will not be established, and many of the opinions advanced in this paper may seem to be mere assertions without inductive evidence, and their accuracy scarcely determined.

Realizing the fact that the human organism is beautifully and wonderfully made, that omniscience is displayed in every atomic formation, in every cell, in every chemical constituent, the ubiquity of the phosphoids in every elementary constituent of the human organism, suggest that they must sustain high relations and perform important functions—functions inseparable from both organic and nerve life, without which nutrition is impossible, and the nerve masses void of sentient or motor power.

The diversity of the formulæ in which the phosphoids exists indicates the subservance of a diversity of purposes. No one of the compounds of phosphorus, whether it be in the formulæ of a phosphide, a hypophosphite, a phosphite, or a phosphate, embody autotoles in itself all the requisites for the high and important mission which devolve upon the several phosphoids. Their protean duties demand protean types, and phosphorus alone, of all the elementary substances, possesses the varying characters adequate to

these duties. Phosphorus can not remain phosphorus in the presence of free oxygen. Dissipated into vapor and brought in contact with heated metals it unites with them, forming phosphides; placed in a bell-jar containing the binoxide of nitrogen, it is transformed into tribasic hypo-phosphorous acid; if boiled with milk of lime or with barium, the result is mono-basic hypophosphorous acid, the hypophosphorous acid contained in the hypophosphites of Churchill. If phosphorus be placed in a funnel in a moderate temperature and the funnel inserted into the neck of a bottle, the clear, sour, dense liquid which will be preserved in the bottle will be phosphorous acid. If burned in dry oxygen under a bell-jar, a white deposit will be obtained—anhydrous phosphoric acid of the monobasic variety, if however the phosphorous be decomposed in the presence of, or by nitric acid, the tribasic variety of phosphoric acid results. These various hydrates of the oxydes of phosphorus would be simply interesting and mysterious, but without therapeutical interest if they did not display certain chemical and physiological attributes which vary their intrinsic merit, as components of the human organism and also as therapeutical agents. Monobasic acid coagulates albumen, abstracts water from the tissues, is entirely absent from plant life, and only in the muscles of animals in combination with potassium. Added to a water, which the anhydrous acid siezes with avidity and combines with the alkalies, the compounds do not become organism and furnish materials for cell development, and yet are not entirely destitute of therapeutical value. Although the soluable lime base it forms has no use in medicine, the monophosphate of ammonium is one of the most efficient therapeutic agents we possess for rheumatism. Pure monobasic acid administered for a considerable time *will induce* rickets, consequently it is valuable in the phosphatic diathesis. The bi-basic may be obtained by heating either a mono-basic or tri-basic salt to redness and isolating the acid from the base. It is unquestionably the condiment and tonic hydrate. In the human organism it is found in the blood, holding sodium as its base. The important part it sustains in equalizing the distribution of the carbonic acid in the blood will hereafter be presented. The pyrophosphate of iron has an immense popularity. The tri-basic hydrate is the one which especially subserves the purposes of nutrition, and without which there is no life.

The three hydrates also possess the power of forming between

themselves innumerable transitions and combinations. These varied transitions result either from its avidity for oxygen or water, the hydrates by the water, the oxides by the oxygen. For oxygen the affinity is strong and from this affinity phosphorus derives its cameleon character. Life, we will know, is inseparable from oxydation, consequently every physical exertion, every respiratory action of the lungs, every contraction of the heart, every digestive process of the stomach, every act of assimilation and sanguification, every mental phenomena, every thought, every passion, every desire, converts a phosphoid compound into a new formula, and in the changes continually accruing in the human organism, these phosphoids become especially prepared for the parts assigned them in the grand purpose of creation; phosphoric acid seems to be inseparable not only from animal but organic life. The uniformity of its presence in both animal and vegetable organisms indicates that it sustains an important function in both these kingdoms and seems to justify the aphorism—without phosphoric acid there is no life. Last year, (1870) I instituted a series of experiments to determine the value of the phosphates in the processes of nutrition. I removed all the phosphates from the food of three dogs, but gave them an abundance of the dephosphated food and confined them in a kennel. In a few days they evinced an almost uncontrollable degree of hunger, walked around their kennel, restless and imploring relief. In a week they evinced rapid emaciation and I am sure if the treatment had been prolonged they would have perished from hunger, but upon restoration of food containing the organic phosphates they rapidly regained their health. A medical friend of mine thought I placed too high an estimate upon the value of the results obtained, and suggested that I should remove the organic phosphates from the food, isolate the phosphoric acid from the salts, and recombine it with calcium and sodium, and give them with the food. I applied this test to a dog. He suffered no inconvenience; I withheld the phosphates from the food for a few days, and he evinced evidences of starvation as observed in the previous cases. Although I was not aware of any one having made similar observations, I have subsequently learned that there had been previous experiments and that others had arrived at similar conclusions as to the essentiality of phosphoric acid in the phenomena of life. These facts connected with the invariable presence of phosphoric acid, prove its value in the processes

of nutrition, and elevates the aphorism of Horsford to the position of an axiom. Accepting then as axiomatic: "That without phosphoric acid there is no life", the conclusion follows as a corollary, that whatever diminishes the quantity, or deteriorates the quality must depreciate in a corresponding degree the nutritive functions, lower the scale of vital vigor, and induce conditions of constitutional deterioration. Food containing a small per cent. of the phosphates, as also a deficient supply of food in which they may be relatively present, by not contributing the amount of the vitalized phosphates necessary for health, induces scrofulous, tuberculous and scorbutic conditions of the system. The long entertained idea that food stands in relative value to the amount of nitrogen it contains is no longer tenable in the light of modern science. Beans and peas are very rich in nitrogenous constituents, and also contain a considerable amount of the phosphates, and yet they are only moderately nutritious. Liebig, recognizing their inefficiency as articles of diet, attempts to explain it on the ground of the small amount of phosphates they contain. This view is scarcely satisfactory, we must seek still further to reach the explicable cause. The phosphate of lime they contain principally belongs to that class of phosphates that are non-nutritious, being to a large extent insoluable in water, and relatively to its insolubility are they void of nutritient power. It is not enough that they be present in the food, but they must belong to the organic variety or else they are incapable of taking part in vital functions. We may then amend the aphorism of Horsford, so as to say " without organic phosphoric acid there is no life." Wheat is recognized as embodying all the constituents necessary for the support of human life. It, I believe, is the only single aliment which attains this standard, and yet wheat contains a much smaller per cent. of nitrogeneous constituents than either peas or beans, but analysis discloses this singular coincidence, the lime base is in association with an acid giving all the reactions of cerebric acid, and this phosphoid also resembles in every characteristic the kephaline of the brain. Take wheat and isolate the phosphoid principles and the result is very similar, it has all the characters of the product with the cerebrin described by most histologists. Wheat also contains a considerable amount of the phosphate of calcium, of the organic variety, hence it contains the phosphoids required in both brain and nerve function, as also in those functions we term organic, hence it embodies the elements re-

quired in organic and nerve life, consequently man can live upon it in the enjoyment of health of body and vigor of mind. There is probably no better acccpted fact than that wheat comes next to milk in the diet of infants. The preparations of wheat in every drug-store gives evidence of its extensive use by mothers to their babes. The explanation is found in the similarity of their phosphoids. Milk contains both cerebric acid and phosphoric acid with calcium, magnesium and sodium as their base, in association with casein, albumen, oleo phosphoric acid and glycero-phosphoric acid. The infant bone at birth contains the magnesium and calcium in the form of a phosphite, consequently it seems at this period that the phosphates are only employed in the functions of nutrition, while the cerebric acid undergoes oxidation and become a phosphite. As the child grows, the lower oxyde is replaced by the phosphoric acid of the insoluable or inorganic variety, and firm, unyielding phosphate of caleium replaces the phosphite of calcium and magnesium.

These facts have also a practieal bearing upon the ætiology of consumption. The opinion is well received that both scrofula and tubercle are diseases in which malnutrition exerts a powerfully exciting influence. The children of the poor are frequently pale, feeble, of low vital endowment, from the inadequaey of food; in childhood they are liable to scrofulous abscesses, or if they reach adult life, they are predisposed to tubercular disease. On the other hand, children that are well fed and supplied with food rich in organic phosphates, enjoy an immunity from scrofula in childhood, and are less liable to tubercular disease in manhood. But many children are really starved who are supplied with an abundance of food. The quantity does not compensate for the quality. As an example: Last December my wife gave birth to a babe—he was healthy and vigorous when born, he soon emaciated, became sickly and in a few weeks seemed to be the victim of marasmus, or rather starvation. Suspeeting the cause I analyzed his mother's milk and found it very deficient in the phosphoid constituents although abundant in quantity. We weaned him, placed him on cow's milk and added to the milk the phosphoid eonstituents of bran. He rapidly beeame a strong, vigorous boy. The miserable scrofulous set of children whieh are found in our public charities attest the deleterious consequences of improper diet. The inference then is, that a milk diet is to a certain extent prophilactic against tuber-

cular disease. Experience seems to corroborate this view. Upon the plains of Tartary a very large amount of mare's milk is consumed by the inhabitants, and those using it are exempt from tubercular disease. Consumptives going there frequently recover their health under its use. Admitting as we must, the dry salubrious climate of Tartary, and the advantage of exercise in the open air on horse-back, it cannot be gain-said that these cannot produce such results without mare's milk. Chemical analysis has demonstrated the superior richness of the mare's milk over the milk of all other animals except the goat's in the phosphoids, and the inference must necessarily be that much of the result depends upon the large amount of the compounds of phosphorus. In the same line of evidence we find eggs and oysters, aliments rich in phosphoids, are of efficacy in the various forms of tubercular diseases, as well as those suffering from brain and nerve exhaustion, as also those in whom there is debility of the procreative functions. The connection between sexual exhaustion, drain of cerebric acid and development of consumption will be hereafter considered. From the line of argument here pursued, the conclusion must be that articles of diet are valuable in direct relation to the amount of the phosphoid principles they contain; that nutrition is inseparable from the presence of the phosphates and that food destitute of these cannot sustain animal life. I think also we have arrived at another fact—the phosphates elaborated in the laboratory of the chemist do not correspond with those developed in the alembic of the vegetable kingdom or of animals. From the experiments upon dogs, it will be noticed that as soon as the nutritious phosphates were removed from the food they began to wane, and the substitution of the laboratory made phosphates did not compensate for the loss. If this idea be accurate, it is an important one in a therapeutical point of view, explaining the general failure of the ordinary phosphates as remedial agents, and establishing the fact that it is only those organized in the vegetable and animal kingdom that are nutritient, assimilable, and can give back to the human organism the required constituents. The fact has been already noticed, *en passant*, that the phosphoric acid found in plants is different from ordinary phosphoric acid—that it forms soluble bases with calcium, manganese and iron—bases that are soluble in water—a fact first announced by Professor Horsford. Furthermore the phosphates found in the urine in health belong to the in-

soluble variety, are the products of tissue disintegration, have served their function and are thus excreted. In phthisis and in scrofula the soluble variety appears in the urine, showing that there exists in the organism a lesion in the assimilating function, the consequence of modified nutrition and the result of butyric acid in the duodenum, which is a consequence in itself of butyric fermentation, depending upon and growing out of inefficiency of the pneumogastric nerve.

The comparative difference of the assimilability of the two varieties of the phosphates, positively proves the destitution of value of the insoluble variety as remedial agents, and moreover this law of assimilation will appear of great moment when we come to apply it to defective nutrition and the part it plays in the development of tuberculosis.

But the lesions in the digestive function are but expressive of lesions in the nervous system—in the modified excito-nutrient nerve function. Going a step further we find modified excito-nutrient nerve function derives its modification from modified influence from the medulla oblongata, it as well as all the nerve masses in which nerve influence is generated, contains certain phosphoid principles absolutely indispensable to nerve function. "Without phosphorus" says Liebig, " there is no thought," and Agassiz has demonstrated that they are employed in every brain or nerve phenomena, are the food of the brain, and sustain as important a relation to nerve power as nitrogen does to muscular integrity, or carbon to the sustaining of animal heat. It may be truly said that they are the especial medium by which the immaterial essence—mind—and the unanalyzed and mysterious principle—life—are connected with physical structures. The high relation they sustain to nerve power and the mutual dependence of both organic and animal functions upon the normality of nerve influence, associates them intimately with both physiological and pathological phenomena. As a medical student—Professor Paine taught me to look to the nerve masses as the point of emanation of vital operations, whether normal or abnormal, while Professor Draper directed my attention to the dependence of life upon chemical conditions. Through these far diverging instructions, I began in 1857 the study of the brain and lungs to fathom the mysteries of tubercular consumption, I found that the brain was replete with phosphoid principles, which I then rudely isolated and determined a deficiency of the brain principle we now

term kephaline in the medulla oblonga, in those dead with phthisis; a normal medulla oblongata containing twenty-eight grains of anhydrous cerebric acid as the minimum amount, while in those dead with phthisis the amount often ran down to twelve grains. Since then others have analysed those brain principles and a resumé of the state of the knowledge of these phosphoids may be of practical importance in attaining pathological conclusions. For convenience I thus tabulate it:

1st. Cerebrin obtained by Gobley ($C_{31}H_{34}O_8$)..

2d. Cerebric acid (normally combined with cerebrin in the formula $C_{42}H_{79}NPO_{13}$), a tribasic anhydrous hypophosphorous acid, by Polk, 1858.

3d. Myelin, by Virchow.

4th. Myeloidic acid, convertible into neurolic acid ($C_{100}H_{90}PO_{34}$).

5th. Kephaline, the normal combination of cerebin and phosphide of nitrogen ($C_{100}H_{79}NPO_{13}$, by Polk, 1858).

6th. Cholin (of Strecke), neurine, of Liebreich, a basic substance ($C_{10}H_{15}NO_4$).

7th. Lecithine ($C_{84}H_{81}NPO_{18}$), a compound of glycero-phosphoric acid and neurine, by Gobley.

8th. Protagon, a combination of kephaline, lecithine and glycero-phosphoric acid, by Liebreich, 1865.

It thus appears that protagon is the embodiment of the phosphoid principles of the brain, and as the representative I will speak of the brain principles as protagon. Kephaline however, contains the greater portion of the cerebric acid with phosphide of nitrogen, and consequently is by far the most important. The German histologists have confirmed my conclusions, that there is a direct relation between the amount of cerebric acid and the cerebrates (for cerbric acid is principally in combination with sodium, calcium and magnesium), and the normal vigor of the nerve masses, consequently whatever depreciates the amount of the cerebrates, will produce a corresponding deterioration of the functions in which the deficiency exists. The medulla oblongata, presiding over the pneumogastric—and the pneumogastric is so intimately blended with the great sympatheticus that modification of nerve influence, by a deficiency of the phosphoids, may produce those lesions in the digestive function which may eventuate in phthisis. Extended observations also sustain this view—that whatever tends to exhaust the

nerve and brain power also predisposes to phthisis. Long continued and depressing emotions, unassuaged grief, intense intellectual pursuits, all tend to excite tubercular disease, and consumption of the phosphoids are inseparable from these conditions.

Chemical analysis of the semen has proved the presence of a large per cent. of the cerebrates. Whatever then induces an excessive drain of the semen, must induce a corresponding loss in the cerebrates, and manifest the consequences of this loss. The proposition is too well recognized to find an opponent—that excessive sexual indulgence, or masturbation are very productive of insanity, and the records of all insane hospitsals, show that all, or nearly all who are thus made insane, die of phthisis, while insanity, even with the loss of liberty and exercise, enjoys an especial immunity from phthisis. The uniformity of this occurrence it seems to me, is an irrefutable argument in favor of the connection between loss of protagon and tubercular disease. In fact, all the evidence brought to bear, seems to render the theory a fact. But all histological research and the results collated on every side, grouped together, exhalt the relation the phosphoids hold to the body, mind and soul. It matters not whether we descend to the simplest organic phenomena, comtemplate the grand evolution of thought, or raise our conception to the infinite and penetrate the mysteries of eternal life, we cannot escape the ubiquitous consequences of the phosphoid. The protoplasm is regarded as the most elementary constituent of animal organization, the general basis of all tissues, and protoplasm is inseparable from the influence of sulphur. Taking the granule as the morphological unit, we find the sulphur trace associated with its organization and internally blended with its life and development. Yet, tracing the morphological unit a step further, watching with the microscope the wonderful revelations it unfolds to us of the hitherto unexplored mysteries of life, we find even the granule depending upon cerebric acid, in association with ammonium, for its development into cell organism and animated fibre. Place the blood plasm, under the microscope and add a trace of the cerebrate of ammonium, and it may be noticed the granules hasten to arrange themselves in corpuscles; less striking dispositions can also be obtained by the cerebrates of potassium and sodium. Here we also get another glimpse into the pathology of tubercle. Tubercles are either granular or corpuscular—are either a blighted granule or an aggregation of granules—a white blood corpuscle.

If then, as Lehman has asserted, and all evidence seems to corroborate, the development of structure in the amorphous protoplasm cannot proceed with the vivifying influence of a phosphoid; modification in the quantity and quality of the phosphoid may so impair the morphological process of the granule or the corpuscle as to blight it, destroy its vitality, and favor its exudation into the adenoid tissue of the lungs and other structures of the human organism, to there abide and constitute a tubercle. Accepting then, cerebric and phosphoric acids in their alkaline associations as the emanators of the morphological phenomena evinced in the growth and development of animal life, the position is unassailable that they wield a predominating power over all nutritive, brain and nerve processes, and display their efficiency in this normality, or abnormality. If they be the organizers and tissue generators of the animal and vegetable kingdom, can we exempt them from the consequences of lesions resulting from nutritive deficiency? What is tubercular disease but an expression of these very conditions; what is tubercle but a blighted protoplasm, receiving its mortal wound in the defective vivifying power of the protagon, and lodged in adenoid tissue to caseate and become the focus of ulceration? Reiterating then, that the sulphur modified protoplasm constitutes the germinal constituent of both vegetable and animal organisms, its normality is inseparable from its correlative kephaline—the vivifying principle of protagon—and is modified by its modifications. Though the granule be the morphological unit from which all tissues are derived, Bennett has demonstrated that it is through the influence of cerebric acid that their arrangement into cells are determined, that it is cerebric acid which coördinates its organization into tissues, and decides all its various morphological results. Then, if all these be the high purposes of cerebric acid, and if the cerebric acid be deficient and inadequate to the result, the unvivified granule must become the granule of Bayle and the leucocyte the corpuscular tubercle.

Reasoning from this standpoint, with these facts, it seems to me, tuberculosis finds a prime factor in deficiency of this compound of phosphorus. In addition, the following quotation from Baron Liebig, shows the important relation of the compounds of phosphorus in the function of respiration. He says: "That there is no known salt, the chemical character of which approaches more clearly the serum of the blood than the phosphate of sodium,

There is none more fitted for the absorption and entire removal of carbonic acid from the organism. When carbonic acid is taken up by the blood, there is established between the phosphoric and carbonic acids an equilibrium similar to that existing in the juice of the flesh between the lactic and the phosphoric acids. In the same way as these divide between them the potassium of the juice, so do the carbonic acid and the phosphoric acid divide between them the sodium of the blood.

If we assume that the carbonic acid seizes a portion of the sodium, we may imagine that the phosphoric acid previously combined with this portion of the base is expelled from the place it originally occupied and thus set free, but it does not on that account separate from the compound. We can say carbonic acid is changed into carbonate of sodium only, when the free phosphoric acid has been removed and employed in another quarter, but in point of fact this phosphoric acid always displays it presence, and retains unimpaired its power of combining with the sodium. The slightest cause coming to the aid of its affinity, so as to give it the preponderence, suffices to displace the carbonic acid and reproduce the original compound. Agitation with air, the spontaneous evaporation of the water in which the compound is dissolved, diminution of the atmospheric pressure, all these causes, which have no effect on neutral carbonate of sodium, produce decomposition, and cause the separation of the carbonic acid taken up by the sodium phosphate in the blood. In this manner the carbonic acid is kept at a constant value. If more carbonic acid enters the blood from the body, more phosphoric acid is set free in proportion, and thereby a more complete separation of the carbonic acid in the lungs is secured. If more sodium is taken up, then a part of the carbonic acid which would otherwise have escaped by the lungs, is eliminated from the system by the kidneys, in the form of the carbonate of sodium."

At first thought the above may seem to be without practical reference, but when we consider the facts here presented, with several known facts regarding the pathology of tuberculosis, the relation between them becomes evident. Prof. Aitken, explaining the causes and processes of tyrosis, specifies a constitutional predisposition, the evidence of which is based on the fact that in some animals all ordinary pus undergoes this change, as in rabbits and sheep. This occurs by the abstraction of the watery part of the

pus, or of the new material, by absorption; a theory also supported by the occurrence of the change in those animals which rarely drink water, and take little or no food, their urine being highly concentrated and their excrement hard and dry. Local anomaly of structure or function, such as may be expressed in the greatest intensity in the lungs; as for example, a relatively small amount of blood in the pulmonary tissues. Hence certain diseases which keep the lungs over-supplied with blood have been observed to be antagonistic to phthisis, by overflow of blood, especially from the pulmonary veins, as diseases of the heart and great vessels. On the other hand, phthisis has been noticed as concurrent with stenosis of the pulmonary artery.

"The rarity of pulmonary phthisis in mountainous countries and in persons whose chests have been thoroughly expanded, point in the same direction; as well as the immunity of those who suffer from chronic bronchitis; and the opposite effect of pleuritic compression as tending to induce phthisis."—*Science and practice of Medicine, vol. ii, p.* 545—546.

We are thus brought to the consideration of the very condition which is most favorable for the separation of the carbonic acid from the sodium, and its involution in the system. When we also consider the consequences of this involution of carbonic acid and its influence in depressing the nervous power and deranging the entire processes of nutrition, we obtain an insight into the morbid processes of tuberculosis.

If abstraction of water gives the phosphoric acid power to expel the carbonic from its association with the sodium, and the dryness of the pulmonary tissues is one of the essential conditions in tyrosis, and one of the concurring ones in tubercular deposit, phosphoric acid in the formula with sodium assumes the position of an exciting and determining cause. In this case, however, we do not reach the initial lesion. The dryness of the pulmonary tissue deranges the relation of the acids with the sodium, but this very dryness may result from imperfect expansion and want of exercise of the pulmonary parenchyma. Depressed nerve power will induce this very condition; in fact, except in stenosis of the pulmonary artery, it sustains the position of an essentiality. As Liebig has said, without phosphorus there is no thought, we can well add, without it also there can be no nerve force.—The essential constituent of nerve structure, the very pabulum of nerve

life, and the element employed in all nerve functions. If it be deficient in quantity, or improper in quality, it will be quite inefficient in performing its innumerable duties.

What relation does impaired nerve power sustain to the development of tubercule? It may be expressed in five aphorisms:—

First: It reduces the capacity of the chest and prevents a requisite supply of oxygen from entering the lungs, induces the dryness referred to, and as I have already observed, breaks up the connection between phosphoric acid and the carbonate of sodium, and thus liberates the previously combined carbonic acid and favors its introduction into the blood, and thus in time becomes an efficient ally of the already existing morbid condition; depresses in a more decided degree the nerve centers, and favors in this manner the development of every lesion that obtains in tubercular disintegration.

Second: It prevents the formation of cells sufficiently vitalized for cell development after the elimination of the blood serum from the blood-vessels; consequently we find the exudation of the liquor sanguinis so low in organizable elements, as to constitute a sick and dying element—cacoplastic or aplastic in its nature, ready to caseate and become the focus of disorganization.

Third: Imperfect cell formation is the consequence of malassimilation; the chyme and chyle are improperly elaborated. The proper ratio between their constituents is deranged; the starchy elements are not transferred properly into glucose, and the fatty and oily elements not properly emulsified; butyric acid is generated largely *instead*, and the albuminous elements which are relatively in excess, are too firmly held in solution for assimilation by the butyric acid thus generated.

Fourth: The impaired vital capacity prevents the formation of healthy secretion in the lining membrane of the lungs; the secretion partaking of the general vital deterioration, the lining membrane of the cells is imperfectly formed. This membrane, it will be remembered, consists of a layer of cells, and like other secreting membranes, is being continually thrown off and becoming mingled with the tubercular matter as it forms in the lungs, and thus furnishing food for the tyromatus processes.

Another fact in this connection somewhat suggestive, is, that the ganglionic nervous system especially presides over and directs the functions of all the secreting membranes.

Fifth: Whatever impairs the nervous functions of the ganglionic nervous system will derange the pulmonary capillaries—consequently we have relaxation, and a large amount of exudation into the air cells results. In this exudation is an abundance of leucocytes, or as Williams prefers to call them, sarcophytes, which here cease their amœboid motion, die, shrivel, and become corpuscular tubercular cellular cells, which I will prove in considering the morbid anatomy of tubercular lesions.

In these five aphorisms are embodied many facts which relate both to the organismal and function sustaining properties of phosphorus, and the consequences of its deficiency on the one hand and the origin and development of tuberculosis on the other. We here see cause and effect very intimately linked together. We find that phosphorus as a protagon, the very food sustainer, prompter and essentiality of nerve structure and nerve function. Again, we find that vital force is displayed through the nervous system, that it is the great medium of communication between the etherial, mysterious essence mind, and the organic functions; that both the electric battery and the wire must be in perfect condition, or the result is abnormal; the vital knot—the throne of life—must be efficient, and also the nerves through which it communicates must be ready and healthy, or the resulting communication will be derangement of function. Notwithstanding the apparent independence displayed by the ganglionic nervous system in its supervision and direction of secretrion, digestion, absorption, assimilation, appropriation, sanguification—in fact the entire processes of nutrition, we find nevertheless, that all these are modified by mental impressions. There is no better established fact than that a shock upon the mind vibrates throughout the entire processes of life. Grief will arrest the series of the entire nutritive processes and induce severe diarrhœa, and even inflammation, of the chylopoëtic viscera. Mind and body are indeed closely inter-related. They are mutually dependent upon each other. Abnormality of brain will induce abnormality of body. The nerves being the channel by which the brain sends forth its power; and also through this medium by reflex action that the brain is informed of physical conditions. Without phosphorus, says Liebig, there is no thought, and if there be no thought there can be no brain or nerve power; consequently whatever modifies the formula of this element must also modify intellectuality, man's emotional nature—his passions,

his desires, the acts of voluntary motion, and his organic functions. The protogon, the combination of hypophosphorous acid with glycerine and olein, we have numerous reasons for believing, are the types of phosphorus which act as the nutrient and function sustaining property of the brain and nervous system. A modification in either its chemical relations or its quantity must necessarily derange the functions over which the nervous system especially presides. Its deficiency in the anterior and superior lobes of the cerebrum would modify intellectuality, while a similar condition in the medulla oblongata, cerebellum and inferior portion of the cerebrum, would manifest the effect in the organic functions. Now, if we could modify all these conditions, if we could supply each organ and tissue with the very formula it requires of phosphorus, we no doubt would have attained a great advance in therapeutics. But so prone is every type of its hydrogens for oxygen that it is difficult to predict what a phosphorous combination will become when taken into the system. Monobasic acids may prove tonic, but they are destitute of organismal power. Monobasic hypophosphites of lime and sodium are only valuable tonics. Beyond this limit they possess no power. They cannot unite with nitrogenous elements to form the compounds of the system. Phosphorus, however, very slightly oxydized, in the presence of oil, glycerine and extract of beef, will form first a nascent tribasic hypophosphorous acid, which will unite with three units of a base, forming chemically and physically the protagon we find in the brain. I believe the very first lesion in phthisis, apart from deficient vital organization, has its origin in a modification of this phosphorus compound.—That from this modification occurs the circle of morbid processes which form the destructive disease, tuberculosis. From it eminates the depreciation of vital force which modifies the functions of nutrition and constitute the chemical conditions which eventuate in the deposit of tubercle in the tissues of the lungs and other organs. But I do believe that the phosphorous modifications are not limited to impaired deranged nerve force, whether manifested through either the cerebro spinal nerve, or the ganglionic system. I have already alluded to the relation of the bibasic phosphoric acid in its combination with the sodium of the blood with carbonic acid, and we have seen how, under certain circumstances the mastery is given to the phosphoric, and the carbonic is imbibed into the system, and we also know

that the very condition most favorable to the result obtains in phthisis.

We know that phosphate of lime constitutes an element in the tubercular deposit, and I think there are potent reasons for believing that the influence of phosphorus and its hydrogens in some manner modify the different complications which spring up in its course. With our present knowledge of the therapeutical and pathological relations of phosphorus we are unable to trace them through all the complications of disease, but I have no doubt that the more we investigate the relations, the more we will find exalted the importance of phosphorus and its hydrogens.

The part sustained in the morbid phenomena is as yet imperfectly understood; there are, however, some well established facts throwing considerable light on both its physiology and pathology. Bernard's experiment in pricking different portions of the medulla oblongata, producing at will in both herbivorous and carniverous animals either saccharine or albuminous urine, indicates the extent to which organs and functions are modified by nervous stages. We already know that injury to the pneumogastric nerve will induce congestion and inflammation of the lungs, and with this knowledge we can easily understand why modifications of the phosphorus element in the nervous system may alter the functions, not only of the nervous system, but destroy the equilibrium of vital actions and throw the entire machinery of the organism into disorder.

The fact that the principal nerves of the stomach, heart, and lungs are the same nerves, gives us plainly the reason why a disturbance of one of these organs is accompanied by more or less derangement of the other. The nerves of the lungs, the pneumogastric and sympatheticus, form the plexus pulmonalis, or the nerve centers of the lungs and heart.

So intimately blended are the nerve centers which preside over the functions of digestion and respiration, that a derangement in one must almost necessarily produce a derangement in the other. If an injury to the pneumogastric will so modify the secretions as to produce both saccharine and albuminous urine, how very easy it is to infer that a morbid manifestation of the nerve function of this and the sympatheticus may also develop all the lesions which spring up and follow in the trail of phthisis. The medulla oblongata I have already alluded to as the very fountain head of the nerve

power which presides over the functions of the pneumogastric, and also exerts a modifying influence upon the sympatheticus.

But so intimately related are all the organs and functions of the body to each other, that not a single one can be disordered without deranging the delicate and complicated machinery of the organism, and modifying in a greater or less degree the operations of the others The nervous system derives its pabulum from the blood, and the blood is also modified by the impressions conveyed to it by the nervous system, and the brain is the source of nerve power and the distinguishing feature of animal life.

The blood is the medium by which the materials of supply are introduced and those of decay are removed from the system, and consequently it is natural when we come to investigate the cause of this disease, and the channel through which it operates, to look to the blood. Bennett however, very truly says, "we cannot halt our investigations at the blood." We must look beyond; we must penetrate in our researches to the pabulum which ministers to the nutrition of the body through the blood. Healthy tissue can only be elaborated by a well directed and vigorous digestive and assimilative function, and this function can only be performed by the excito-secretory nerve system, which presides over, and furnishes the necessary stimuli to perform these functions, and the excito-secretory nerve system also depends upon a vital principle—the essence of life—unanalyzed and unanalizable;—an emination from the hand of the Deity; the governing principle of animated nature. But this vital principle must have a well organized and healthy nerve-structure through which to act; and to be healthy, it must possess a full proportion of all its constituents in their normal formula.

We have already considered the relation of phosphorus to nerve structure, and I have abundant proof that the value of phosphorus in neuralgia is in supplying the hungry nerve with food, and the proof that phthisis is an emination of deficient nerve power.

This brings us to the first link in the chain of causation of tuberculosis—deficiency of this element in the system. And in consequence of this deficiency, there is a depreciation of nerve vigor and consequently inefficiency and malperformance of duty by the thoracic and abdominal plexus of the excito-secretory nerve system. The type of phosphorus impaired in its quantity, and perhaps also

in its quality, is the anhydrous hypophosphorous acid of the tribasic variety, in combination with olein and glyeerine.

I have now traced the tubereular formation from its primitive cause to the lesions that cause induce, and find that the chain is thus linked together: Imperfect brain power, impaired digestion, generation of butyric acid, neutralizing the pancreatic juice, which is normally alkaline, and thereby deranging the relation between the oleaginous and albuminous elements of the food. We are also in possession of a suggestive fact: Butyric acid masks all tests for phosphorus, and it seems to me to be also concerned in the modifications of the quantity and quality of the hydrogens of phosphorus; that owing to the lesions thus induced, we find an excess of albumen in the blood, deficiency of the normal oleaginous elements, a predisposition in mucous membranes to congestion—owing to the deranged condition of the organic nervous system—dilitation of the capillaries, and exudation into the pulmonary parenchyma of an albuminoid fluid containing tubercular corpuscles. These are of a very low endowment of vitality from their earliest birth; they are but born to die, and with an innate tendency to decay. The first step in the downward course, is to induce a condition of lung, almost if not identical with, gray hepatization. By further changes this breaks down into cheezy masses; excites irritation, inflammation, ulceration, disorganization and usually death. That in the tyromatous process, a virus is created capable of perpetuating the blood lesion independent of the first lesion in the processes of nutrition. This idea is supported by all the facts developed in innoculation. This is not difficult to comprehend when the origin, nature and history of the tubercular corpuscle is considered. If the tubercular corpuscle be, as I think it is, a white blood corpuscle, bioplast, leucocyte—or as Williams prefers to call it—a sarcophyte, either of feeble vital endowment from its birth, or becomes unhealthy through morbid impressions of the blood, that it escapes with the exudation, dies, shrinks, and becomes a miliary tubercle, or absorbs portions of the albuminoid fluid, caseates, and becomes a gray tubercle, very much of the uncertainty respecting tubercular processes at once vanishes.

The objection to this conclusion is that there is a variance of size between the sarcophyte and the tubercular corpuscle, but this objection is founded in error. There are several kinds of sarcophytes; some round and small, not attaining the size of a red blood cor-

puscle. These are composed of thin layers of cell substance investing one or more nuclei, and may become either spheroidal, or flattened by compression. Others are also found associated with these, attaining the usual size and form, and also have one or more nuclei. Besides these we also find amœboid (or emigrating) cells, both finely and coarsely granular, as also various intermediate forms and sizes between these. In freshly drawn blood these last appear as more or less rounded, or of irregular shapes. And another fact is also here presented: At the temperature of 94—104°F., these sarcophytes display quite active motion, resembling the motions of the amœba, from which peculiarity they are called amœboid bodies. However, when the temperature is elevated to 110° or 120°F., their motions cease, and the cells shrink and harden. The sarcophytes, as long as they preserve the power of motion, also possess the power of imbibing particles into their substance and of digesting the liquids in which they float. This function, long suspected, has been verified by experiments with carmine, analine, and milk globules. The latter were digested while particles of the former substances seem embeded in the sarcophytes. If the sarcophyte be as Beale considers them, masses of structureless germinal matter—the kind of matter which is concerned in the production of everything that lives, and is always derived from matter which had existed before it—the *granular matter detected in them, and supposed to enter into the formation of their substances, being, in fact, only the debris resulting from change, after death*, the inference coroborates my view of miliary tubercle. However, many of these sarcophytes exhibit well defined nuclei in freshly drawn blood, and these nuclei can readily be detected in active amœboid corpuscles, so that it seems that these masses are almost constant elements in the structure of colorless corpuscles, and no doubt also constitute the nuclei observed both in the pus and tubercular corpuscle.

It seems to me that the evidences in favor of a tubercle being a blighted and dead sarcophyte, are very conclusive. Derangement of the organic nervous system is no doubt immediately concerned in the pulmonary exudation with which these sarcophytes escape from the pulmonary vessels into the pulmonary tissue to die, shrink and granulate, or imbibe albuminous elements and form the gray tubercle, fill up the alveoli and adenoid tissue, and either undergo fatty degeneration and absorption or calciferation, or soften, become

cheesy, and form a focus of destructive ulceration. We also find a similar condition of abnormality ensue when the sputa, blood or tubercle is introduced into a lymphatic gland of a previously healthy animal, and very similar deposits also follow innoculation, by pus from foul ulcers, decayed blood and other septic matter, although I believe from my personal observation that the latter do not induce the same abnormality as the former, although the resemblance between them is indeed very finely shaded; the same however, may be said of septicæmia and tuberculosis. However, it should not be forgotten that septic innoculations will induce in man either septicæmia or embolism, and neither gray or miliary tubercle. In the following description of the action of the poison of the cobra, I think we see some pathological facts which throw some light upon the action of a virus acting upon the blood, and also obtain some intelligent views of the processes attending the development of tubercle:

"When a person is mortally bitten by a cobra de capella, molecules of living germinal matter are thrown into the blood, and speedily grow into cells and as speedily multiply, so that in a few hours millions upon millions are produced at the expense, as far as I can at present see, of the oxygen absorbed into the blood during inspiration, hence the gradual decrease and ultimate extinction of combustion, and chemical change in every other part of the body, followed by coldness, sleepiness, insensibility, slow breathing and death. The cells which render the blood unfit in so short a time to support life are circular, with a diameter of $\frac{1}{2,800}$ of an inch in breadth, which, when further magnified, is seen to contain still more minute sporules of living germinal matter. In addition to this, the application of magenta reveals minute colored spots of some points of the circumference of the cell."

This indeed, describes a very acute form of phthisis; much more rapid indeed than any included in that nosology. The very cells he here describes cannot be aught else than sarcophytes abnormally developed and rapidly consuming the oxygen, and thus inducing death. In tuberculosis we witness the same event, only in the latter it is grain by grain that the mortal frame wastes and withers away. May we not reconcile some of the German innovations, false as they mainly are in their conclusions, with these facts, and reach an explicable cause why a cheesy deposit in the lungs or other portion of the system may impress the sarcophytes

brought in contact with them and induce the metamorphosis we term tubercle? I can see nothing impossible in this, nor anything at variance with the general laws governing the origin and development of phthisis, from inherited or acquired constitutional peculiarities. It does not overthrow the doctrine that phthisis, or rather the defective organization on which phthisis depends, or in which it originates, is inheritable and may be transmitted from parent to child, but only confirms what seems to me to be axiomatic: That tuberculosis may accrue from all these sources, and subsequently, it matters not what may be its factors, become subsurvient to hereditary laws, and thus different in no manner from inherited disease. We certainly obtain the only rational view of the deposits that take place in innoculation with pus, tubercular matter, decayed blood, or other sceptic material from this standpoint. With this explanation, there is nothing obscure in the fact that the morbid condition of the sarcophyte may result from the consequences of malassimilation or from septic matter in the circulating fluid, although I cannot recognize the precise identity of the two results. When, however, we take into consideration the identity in form and chemical constituents of pus and tubercle with the sarcophyte, much that is otherwise obscure in the pathology of these, becomes intelligible. We can easily reconcile the origin both of the pus and tubercle with sarcophyte, and comprehend more intelligibly the manner by which the pathological may accrue from the physiological product. We are thus enabled to trace the malady to its first developing cause, and understand how the disease may be originated independent of hereditary influences or physical conformation, and thus set at rest some idle and unprofitable theorizing upon the origin and development of tubercle. It is evident that tubercle can result from a morbid condition of the function of nutrition, whether congenital, or resulting from certain coördinating causes influencing one previously free from inherited taint.

The first observable deviation from health manifested, is dislike to fatty articles of food, accruing from inability of the digestive organs to reduce these to a condition for assimilation. This inability arises from deficiency of pancreatine poured out to emulsify the fatty elements of the food, and this deficiency of pancreatic fluid is the immediate result of impaired organic nerve function. With this derangement there also exists, as described by Bennett, "an

excess of acidity in the alimentary canal, whereby the albuminous constituents of the food are rendered easily soluble, while the alkaline secretions of the saliva, and of the pancreatic juice are more than neutralized, and rendered incapable either of transforming the carbonacious constituents of vegetable food into oil, or of so preparing fatty matters introduced into the system as will render them easily assimilable. Hence an increased amount of albumen enters the blood, as shown by chemical analysis, while fat used for caloric is largely supplied by the adipose tissues of the body, causing the emaciation which characterizes the diseases. In the meanwhile the lungs become especially liable to local congestion, leading to exudation of an albuminous kind. This in turn, being deficient in the necessary proportion of fatty matter, elementary molecules are not found so as to constitute nuclei capable of further development into cells; they therefore remain abortive, and constitute tubercular corpuscles. Thus local disease is added to the constitutional disorder, and that compound affection is induced which we term phthisis pulmonalis, consisting of symptoms partly attributable to the alimentary canal and partly to the pulmonary organs."

From this view we can conclude that an oily emulsion must be formed to constitute a proper chyle to be converted into blood, and that in pulmonary and other forms of tuberculosis this process is interfered with, and that in consequence a state of constitution is induced favorable to the deposition of tubercular exudations into various tissues, but especially into the pulmonary organs. As has already been stated, the blood is vitiated, altered in character, and of a low vitality; the cell formation takes place with diminished energy, and leads to defective structural growth; the tissues are consequently delicate, the organs weak, and easily deranged. Pathological chemistry and microscopic research go a step beyond this, and afford ground for believing that in the portion of the recently formed blood, proteiniform and oleaginous principles are not only not perfectly elaborated, but also the oxygen, hydrogen, nitrogen, or carbon, and some of the primary compounds, are either in excess or deficient; that the abnormal proteiniform compounds thus produced are less organizable than those produced in health—more apt to become granular, more prone to aggregate in masses; the fatty matter is of a lower grade than healthy fat, and approximates to the nature of cholesterine, and these deviations from the healthy type, both of the blood and blastema, from which the

tissue is formed, produce the various anomalies in the growth and development of the body, and give rise to products which constitute the pabulum of tubercle.

We have also several additional facts which, grouped together, aid us in appreciating still more clearly the rationalé of the morbid process by which the tubercle is deposited. First: The albuminous character of the fluid material which infiltrates the tissues of an organ previous to the process of tuberculization, by which the infiltration is in part changed by coagulation, into the deposit in which tubercles are developed. Secondly: An obvious affinity between lymph of the blood and tubercle, as demonstrated by Allison. Thirdly: The albuminosity of the blood, already referred to, and its connexion with acidity of the intestinal canal. Fourthly: There is the peculiar state of the blood, amounting in appearance to leucæmia, which immediately succeeds digestion in healthy persons, resembling the molecular and corpuscular elements of chyle, or lymph, and consisting of fats emulsified with albumen. To this substance Panum gave the name of pabulum, which is further elaborated in the blood, in the glands, and in the lungs, before it takes part in the general morphological changes connected with nutrition. Fifthly: The observations of Panum and Parkes relative to the precipitation of albumen by acids and neutral salts, in which Dr. Parkes especially shows that the albumen, as it exists in the blood serum, is usually in that condition in which it is most readily precipitated by acids and the chloride of sodium.

To my mind, with the above facts relative to the blood in phthisis, the circle of morbid action is completed:—Deficiency of the hypophosphite of olein and glycerine—the protagon in the brain, and blood, and nerve structure—and in consequence of this inefficiency, impaired and modified nerve influence, exerted through the thoracic and abdominal plexus of the excito-secretory system of nerves, deficiency of pancreatic secretion and an excessive acid condition of the intestinal canal, by which the alkaline secretions of the salivary and pancreatic glands are more than neutralized, the fatty elements in consequence are not properly emulsified: the heat creating materials are not furnished in an adequate amount to generate sufficient animal heat for the purposes of animal processes; adipose tissue is consumed in the production of animal heat, producing the emaciation which characterizes the disease. In consequence of the butyric acid in the intestinal canal and the aberra-

tion of other functions of the chylopoëtic viscera, the albuminous elements are not properly elaborated to assimilation, and in consequence of the malassimilation the more than naturally liquid albuminous elements are infiltrated into the lungs, in which event the relaxed and dilated capillaries play the part of a concurring cause. With this exudation there also escapes a corpuscular body which is the tubercle proper, and which I think I have satisfactorily demonstrated to be a blighted leucocyte, or as Williams terms it, "a sarcophyte." I am confident that butyric acid is largely concerned in these consequences. It seems to play an important part in the pathology of diseases arising from malassimilation, by holding the phosphates too firmly in solution, and thus preventing their appropriation for the purposes of nutrition.

Another well-known condition of high import also deserves attention. The large amount of phosphates in the urine, and also the formulæ of these phosphates, the soluble phosphates are rather hypophosphates, which do not abound in health. The insoluable phosphates are the products of tissue metamorphosis in very much the larger proportion, and the presence of these far exceed the normal standard. We must however, attribute the presence of the latter variety to the products of tissue disintegration, while we must look to the functions of digestion, assimilation, and appropriation, as the source from whence they come. As butyric acid is antagonistic to the assimilation of the phosphates, as well as the albuminous constituents of the blood, I regard it as the intervening impediment of the processes of nutrition. But butyric acid is the product itself of malnutrition, resulting it seems, in the very condition which induces the disordered relation between the fats and the albuminous elements of the food. This view receives support from the therapeutics of phthisis. Whatever improves the digestive function ameliorates the disease. Cod-liver oil, nitric acid, and phosphoric acid act in this same manner. In some cases nitric acid with taraxicum and tonics will stay the morbid processes, and perhaps obtain an armistice for several months. It is, however, only in the early stages such results are obtained. Nitric acid no doubt accomplishes its therapeutical results by altering the digestive secretions, and preventing the ferment in which butyric acid has its birth—the result of impaired organic nerve power—so thus we find several associations of lesions before we reach the final result—development and deposit of tubercle—and it is only by

taking this inclusive view that we can comprehend the various conditions in which it originates; but after tubercle is once developed, or the leucocyte becomes of impaired vitality, a ferment seems generated in the blood capable of perpetuating the condition. We may have many proofs of this. The experiments with innoculation in which there is no necessary aberration of the function of nutrition places this fact beyond per-adventure. The tubercle is situated both inside and outside of the alveoli, but displays a strong election for adenoid tissue; in fact this election is so strongly marked, that Burden Sanderson regards tubercle to be simply an overgrowth of this tissue of impaired vitality which degenerates, undergoes tyrosis, cheesy metamorphosis, excites irritation, inflammation, and the other concomitents of tuberculosis. The view gains some support from the fact that wherever this tissue abounds, there also may tubercle be found. The supra-renal capsules, the malpighian bodies of the spleen, Peyer's glands of the ileo-cœcal sack, contain adenoid tissue in abundance, and in them also do tubercle abound.

While dissenting from the anatomical views of Sanderson as to the nature, I cannot but acquiesce very nearly as to the seat of the deposit. As already stated, I regard tubercle as a blighted sarcophyte, but may not this sarcophyte be poisoned and blighted by a virus generated in caseous degeneration of an albuminoid exudation? I believe it often is. The experiments of myself, and those subsequently by Williams, Fox, Waldberg, and others, in innoculation, render it probable that such is the manner in many cases. In fact Buhl advocates this very doctrine. But tubercle is also found prior to cheesy metamorphosis. Gray tubercles are composed of cells, but these undergo metamorphosis with the tubercle itself in its change from the gray to the yellow, so that in the latter they are shrunken, blighted, shapeless; degenerating with preponderence of granular matter with oily particles. It always seemed to me that the oil cells result from the lesion of function in the pancreas and duodenum, and is very significant of the morbid processes by which malassimilation in a peculiar diathesis may develop tubercle.

TREATMENT.

The treatment of phthisis may be very properly divided into prophylactic, hygienic, and therapeutical:

The prophylactic, sufficiently early begun and intelligently and

perseveringly followed, will obviate the constitutional peculiarities upon which the tubercular diathesis seems to originate, or in very many cases seems to depend, or be very intimately associated in its origin and development. The difficulties, however, encountered in recognizing in all cases this diathesis, in consequence of many errors heretofore entertained as to the physical conformation and peculiarities, as well as to its origin and the dependent circumstances on which the tubercular germ is awakened into activity and developed, and in enforcing, even when these are recognized, proper regulations of food, habits, exercise, emotions, passions and desires, have in a large measure deterred the physician from asserting his prerogative and performing this important duty, *i. e.:* the nipping in the very bud of this germ, which, aided by infractions of physical laws, may light up a degree of disintegration which neither hygienic nor medicinal measures are adequate to subdue.

The constitutional predisposition being recognized, we must inquire minutely into the history of the person and his ancestors through several generations, as the disease often skips one or two generations and yet appears in subsequent ones, whether the predisposition to tubercle is inherited or acquired.

In cases where the diathesis has been acquired by sufficient of the causes heretofore stated, the removal of these causes is of the first importance; with these still in operation no treatment can avail much, and the disease will progress to a fatal termination. Unfortunately however, poverty, which is very often an obstacle beyond the power of the physician to remedy, interposes and thwarts every plan and purpose he may desire. Unwholesome and scanty allowance of food; clothing inadequate to protect the body from the vicissitudes of season and climate; damp, imperfectly ventilated apartments; crowded bed-rooms, where the air, not being renewed by proper means, and contaminated by the exhalation from the lungs and skin of others, all conspire not only to realize, but to exceed the effect of any remedial agents while these are in force. Unwholesome food, by deranging the digestive organs and preventing the elaboration of blood, produces debility, and thus depresses the vital forces to a degree that disqualifies them for repelling the inroads of morbific influences; when in addition to the bad quality of the food, it is deficient in quantity, the consequences are in a higher degree marked. The blood becomes deficient in red corpuscles; the white blood discs relatively more

abundant; the capillary circulation feeble, and any pre-existing diathesis more quickly manifested. Proper food is then an object of the first importance; one upon which hinges in an important degree, our success or failure in the management of every form of phthisis whether it be the pneumonic or tubercular form. So various, however, the peculiarities of different persons, that it is difficult to lay down arbitrary rules that will apply without modification to each and every case. The food, however, should be nutricious, and as rich in oily and carbonacious elements as possible; and as freely eaten as the digestive organs will permit without inconvenience. Let it however, be recollected here, as in every other item apertaining to the treatment of this disease, preserve first, last, and above every other consideration, the integrity of the digestive functions. Oysters are a favorite article of diet with me in this disease; nothing else in my hands seeming to sustain the flesh and strength in an equal degree, or so generally agree with delicate stomachs. Whether this claim be sustained or not, I can give personal evidence of the facility with which they are borne by stomachs that are nauseated by everything else, and of the rapid convalescence under their use as a diet. They are very rich in phosphorus, and if my theory be correct, may they not be the best medium by which phosphorus can be assimilated into the system to restore the organic nervous energy, by which the function of organic nervous life may be vigorously performed, and the digestive aberration—imperfect emulsion of fats, excess of the albuminous over the fatty elements, and malassimilation of the alkaline phosphates modified—if not remedied?

Milk is another article of food in which I have much confidence. To secure its best effect, it should be given as Niemeyer directs, fresh from the cow; so as to secure the entire constituents of the milk, the loss of the cream by skimming seeming to deprive it in a great measure of its dietetic merit. A combination of oysters, crackers and milk, may seem like an unpoetical breakfast, yet I can cite one instance at least in which this diet and proper attention to hygienic measures without any other medicinal agents, seemed to arrest a case in which a considerable vomica existed in the right lung. Six months have now elapsed, and the health remains good, although I am not certain that the result is permanent.

Trousseau, the distinguished author of *Clinical Medicine*, (a par excellent work, without which no library is complete), places high

estimate upon extract of malt. I have used it in many cases, and can concur with the learned Professor in its valuable tonic properties. I have always used Hoff's, except in a few cases where I have prepared a stronger preparation myself. Brown stout, however, seems also to do much good, and I presume it is not very inferior to the malt extract, in about twice the amount to the dose of the malt extract. I usually give a wine-glassful thrice a day, administered an hour before meals; it seems to prepare the stomach to receive kindly the cod-liver oil emulsion which I usually administer half an hour afterwards. Meats rich in osmazone should be preferred. Roast beef, roasted or broiled birds. Eggs are valuable, and should not be overlooked in the diet table of the consumptive. They are rich in phosphorus, albumen, and nitrogenous elements—elements demanded, and of the highest value in a disease which day by day and grain by grain wears away the earthy tenement of the soul.

While rich diet is important, and proves one of our most efficient remedies in counteracting the diathesis when already developed, a deficient and innutritious diet is very potent in producing an impairment in the vital forces, which light up, if it does not generate *de novo*, the scrofulous diathesis. This is well marked among children in our alms houses, children's homes, and other charitable institutions. I have yet to see a single child that has been an inmate of one of these charities for two years, that does not evince this. Girard College is not included among these; in that institution the strictest attention is paid to every hygienic law, and the consequence is, a vigorous class of youths go forth into society, to become useful members, and very often some of its brightest ornaments.

The cause above mentioned, I am sorry to say, is not confined merely to public charities. Richly endowed public institutions or schools, may be so managed, and have been so managed as to become hot-beds for the generation of scrofula or tuberculous diseases. The same remark as often applies to private as public schools; not merely as respects food and clothing, but also as regards ventilation, light, sunshine, and purity of air. The constitutions of the industrious poor are sacrificed on the altar of gain, and too often it is found that municipal governments lend their aid to the immolation, that they may receive the unrighteous support of the priest of mammon in perpetuating their power, their patronage and the

aggrandizement of their satellites. The physical and moral amelioration which salutary measures would impart to those most in want of them cannot be afforded out of the luxuries and patronage which these governments too often bestow on their supporters and themselves. The cloak of humanity too often covers the most heartless selfishness, and under its guise the most cruel extortions are made. The worst corruption invests the most sacred places, and

> "Man's inhumanity to man,
> Makes countless thousands mourn."

Copland says: "Among the lowest classes, especially in large and manufacturing towns, the frequent recourse to anodynes and carminatives containing narcotics, sedatives, etc., in order to procure sleep or quiet for infants and young children, and to allay their wants, cravings of appetite and irritations of temper, is of itself no mean cause of their weakness of constitution; of imperfect development of both body and mind; of scrofulous and tuberculous formations, and of various other diseases, as they advance to puberty and manhood."—*Dictionary of Practical Medicine: Art. Scrofula.*

I could not quote from a higher authority, and have no doubt that his views are entirely correct. If it be so in Great Britain, where the use of these abominations are confined principally to the poorer classes, what must the consequences be in this country, where the evil pervades every class and condition of life. By far the most elegant method of thus poisoning infants yet invented, is the famous so-called "Winslow's Soothing Syrup." Various analyses have proven beyond question that each ounce contains the large amount of one grain of morphia. When we consider the large doses in which it is given, it is surprisingly strange that the numerous deaths from its use are seldom brought to light and that the grave holds sacredly so many of its secrets. It is computed by a reliable authority that two millions of bottles are annually consumed in the United States. If this statement be accurate, the mischief inflicted by this nostrum must indeed be very great. It is no doubt a potent agent in inducing the injuries described by Dr. Copland, and will tell most unequivocally upon the physical constitutions of the succeeding generations of the United States. I hope outside of our country such health-destroying agents are much less frequently used.

The crowding of young persons together in ill-ventilated schools, shops, and especially sleeping apartments are evils well recognized, understood and deprecated by the profession, and yet this fruitful source of feeble constitutions, scrofula and consumption is unheeded, and the evil goes on, annually contributing a potent influence in swelling the list of victims of these and many other diseases. Until society recognizes the importance of acting upon this subject—until these consequenses are proclaimed and re-proclaimed in every home, in every city, in every town, in every village and hamlet, until society is awakened to this evil, we can only deplore it, without the ability to accomplish anything. Even the masses of the profession, however, I believe do not entertain sufficiently enlarged views on the consequences of imperfect ventilation and breathing over again air that has not only been deprived of its life-giving properties, but is also poisoned by exhalation; but to review this here would be reiterating only what has already been better said by Parkes in his able treatise on hygiene. Another evil also to be avoided is the overtasking the brains of young persons in schools, and confining them so many hours without the necessary relaxation and amusement so necessary to their well-being and proper development. No doubt the impaired vitality which has paved the way to so many cases of phthisis, has had its origin in the confinement and overtaxing the brain in youth.

Sexual excesses too early begun and often unnaturally followed, is another prolific source of deterioration of our youths and young men. The prostrating and ruinous influence of self-abuse, it is a recognized fact, is far more rapid and ruinous in its effects than natural sexual indulgence, even if committed to the same extent. In preventing phthisis this is one of the most potent evils with which the hygienist, the physician and the moralist has to deal. Overcrowding bed-chambers is one of the means of propagation, and to remove this pandora box of numerous evils, demands well-directed attention: Separate rooms, free ventilation, moral influences, plenty of good, wholesome food containing sufficient oleaginous elements, out-door exercise, and proper physical training, are the proper means for obviating this, as other prominent excitants of tuberculosis.

HYGIENIC TREATMENT.

I have cursorily passed over the predisposing causes to the development of tubercle, and referred to some that more immediately

concern the parent and teacher than the physician. I now come to the management of the incipient and developed disease—the field of action into which the physician first enters. The sense of weariness, the loss of strength and flesh, and the slight, hacking cough, suggests to the patient that he is not quite well, although he attributes but little importance to his ill health. He casually drops into his phyician's office and "begs pardon for annoying him with so slight an indisposition, and thinks a dose of medicine is only required." The physician examines the chest; the vesicular breathing in the upper lobe of one of his lungs is interfered with, and percussion announces that the resonance of the same portion is somewhat modified—is dull, the cough is dry, consequently it is not bronchial; the throat and uvula are normal, so we cannot attribute it to that source; the liver manifests no enlargement, so we must excuse the liver and realize that the case we have to deal with is phthisis; be it pneumonic or tubercular, and the opportunity is now presented, if ever, of adopting such measures as will effectually arrest further tubercular deposit, or pneumonic disintegration. As I have stated, impaired organic nerve function, a peculiar form of dyspepsia, acidity of the intestinal canal, deficiency of pancreatic fluid and excess of albuminous elements, with improperly emulsified oleaginous elements, with want of action of the upper part of the thorax, constitute the principal features of the disease. To accomplish a cure, sedentary habits must be abandoned; the cares and duties of the counting room and office must be laid aside; depressing emotions be dispelled, and regular and moderate exercise in the open air be taken daily. Especial care must be used to force the air into the upper lobes, and he must refrain as much as possible from abdominal breathing. The natural tendency of impaired strength is to breath with the diaphragm, and avoid thoracic breathing. As stated already, the deposit is almost always first in the upper lobes, and may not this quiescence of the thorax have something to do in making it the point of the tubercular deposit? If so, this becomes an important item of treatment. Stagnation may ensue from this quiescence, and the infiltration so often observed may take place more rapidly in consequence; and other changes found in the tubercular lung, it seems to me, may occcur from the same source.

A rich, nutritious diet, composed of eggs, oysters, fish, beef, butter, and other articles rich in nitrogenous and phosphorus ele-

ments, should be as freely eaten as a normal condition of the digestive function will sustain. Every habit and mode of life should be systematized: The hour of retiring, rising, eating and exercising, should be fixed, and closely followed. The bowels should be kept regular; one evacuation daily should be secured. It is always best to obtain it without drugs, if possible. Oat meal in gruel, or other modes of cooking, bran bread, bran soup, (as given in the prophylatic diet) may be given as circumstances or caprice may determine. Dates, figs, and roast apples may sometimes be unobjectionable, but as a rule they are not desirable, owing to their tendency to ferment and augment an already acid conditon of the duodenum. The same may also be said of manna and some vegetables, which would be excellent under different circumstanees. Drastic and debilitating eathartics must also be avoided. Rheubarb and aloes, with leptandrin and soap, will form an excellent combination. They may be proportioned thus:

℞.	Pulv. rhei,	gr. xx.
	Pulv. aloes,	gr. x.
	Leptandrin,	gr. x.
	Saponis,	gr. v.
	Divide in pill No. xx.	M.

Sig.—One or two pills every night or every other night.

In this manner a natural evacuation may be secured in the morning. A tonic medieine is indicated; I esteem the following:

℞.	Tinc. cinchona comp.,	℥iv ss.
	Spts. ammonii, arom.,	℥ss.
	Curacao cordial,	℥iij.
		Misc. et sig.

Take a tablespoonful thrice daily before meals.

The indications fulfilled by this combination are to neutralize the butyric acid in the small intestines and to invigorate the gastric digestion. It constitutes an excellent prelude to the administration of cod-liver oil and the kephaline, which is, chemically, hypophosphorous acid of the tribasic variety, in combination with albumen, oleine and glycerine.

When we survey the morbid conditions attendant upon tuberculosis—the deranged relations between the fats and albuminoid elements of the chyle, the digestibility of the cod-liver oil and its

assimilation, we naturally think of it as the most desirable of oleaginous substances to supply the amount required in the development of normal chyle. No other oil is so well adapted to this metamorphosis. But the value of cod-liver oil does not end with the part it plays in supplying a ready emulsible form of oleine, or the immediate influence it exerts in molecular evolution. It acts a direct part in absorbing and neutralizing the butyric acid. We have already referred to Dobell's hypothesis—claiming "pancreatic deficiency to be the first great cause of tuberculosis," as also that of Bennett, the excessive acid condition of the small intestines to be the cause of pancreatic deficiency and the especial morbid phenomenon from which other morbid conditions emanate, by more than neutralizing the normally alkaline condition of the pancreatine and thus interfering with the emulsion of the fatty elements of the food in the small intestines, the molecular development of the chyle, and the excessive albuminous condition of the blood, which induces an irritability of constitution and predisposition to exudation from the capillaries into the adenoid tissue inducing that hyperplastic condition of the glandules which constitutes the tumor tubercle. But these, as I have already stated, are consequences of the original cause—deficiency of the protagon found in the blood, brain and nerve structure—and the immediate result of this deficiency is a deranged and depressed condition of the organic nervous system; the direct source of organic functions. From this view it is evident that cod-liver oil must exert a very salutary influence upon tuberculosis; will correct to an important degree the lesions in the digestive function, and as it contains one part in one thousand of kephaline, it in proportion to this amount contributes to an effectual cure.

Statistics prove beyond question that cod-liver oil has cured many cases. But these results cannot be attributed entirely to its ready appropriation by the lacteals or the kephaline it contains; it embodies another very valuable one—the chloride of propylamin. The value of the latter agent has been pretty extensively demonstrated in rheumatism, and the verdict has been in its favor. In rheumatism there is an excessive development of lactic acid; this the propylamin corrects. In tuberculosis, we have butyric acid in the small intestines, and I have no doubt that a considerable part of the benefit of cod-liver oil accrues from this attribute. Moreover, this position is strengthened by the recollection of the fact

that cod-liver oil was a popular remedy in rheumatism long before it was used in tuberculosis.

Basing my therapeutics upon the above deduction, I have found pulmonary tuberculosis a much more curable disease than it has been hitherto deemed. The kephaline in the cod-liver oil is, however, very often inadequate to supply the deficiency of the hypophosphite of oleine and glycerine, and consequently insufficient to a cure. To meet this exigency I, as early as 1857, investigated the chemical character of "protagon:" I then determined that it was hypophosphorus acid in combination with alkaline bases, albumen, oleine and glycerine, and that the hypophosphorus acid did not belong to the ordinary variety which unites with but one atom of a base, or a monobasic acid, but that it possessed the property of uniting with three atoms of a base—a tri-basic acid, comprehending the law which is common with all the phosphorus acids—that if the acid be developed in the absence of a nitrogenous element it will be mono-basic, while the presence of a nitrogenous element, will develop the tri-basic variety. I decomposed transparent phosphorus dissolved in pure olein, to saturation, and mixed with one-tenth part of beef juice under very heavy pressure of dry oxygen, formed by heating chemically pure chlorate of potassium until every evidence of free phosphorus was obliterated; this I administered with cod-liver oil. A formula varied to meet the peculiarities of individual cases, may be thus constructed:

℞. Hypophosphite of oleine, ℥j.
Cod-liver oil, ℥xv.
M.

Of this a tablespoonful may be given three to four times a day. It increases nerve power, removes the lesion in the digestive function, promotes the elaboration of a healthy chyle, and develops blood teeming with the elements of life and reproduction. If given before there be formidable disintegration of tissue, it will almost universally restore perfect health.

The hypophosphite of oleine is an easily made pharmaceutical product. The only apparatuses required are a Florence flask, with a glass tube extending from the flask to the bottom of the bottle containing phosphorated oil. The bottle should be about one-fourth full, and have a cork pieced with another glass tube extending a little below the cork. The phosphorus placed in heated oil saturates it; when it is cool filter it. Then

mixing the oil with one-tenth of its measure with beef essence, the apparatus is adjusted. Dried and powdered chlorate of potassium is then mixed with half its weight of the per oxide of manganese and a gas flame applied. This develops oxygen, and the oxygen combining with the phosphorus in the presence of a nitrogeneous body forms a combination identical with the olei hypophosphite of the brain. The advantage of this compound is, that it may be mixed with cod-liver oil and thus given. Its advantage is decided, the therapeutical result far exceeds that attained when cod-liver oil is given without it. I regard it as a very important addenda, rather than a substitute for cod-liver oil, and it is one I can recommend with much confidence to the profession, believing they will obtain results more satisfactory than has hitherto been customary in tubercular phthisis. The fact of its being oleaginous and rather nauseous, associated with the general use in cod-liver oil, may be objections, but I also do not think that these objections justify its rejection. My attention, however, was attracted to the fact as early as 1857 to the conclusion, that phthisis found its prime factor in deficiency of brain phosphoids, and I availed myself of the German and French histologists to form a solution of brain phosphoids for therapeutical purposes. My first application of the theory to the treatment of phthisis was in the case of Mrs. Jane Pride, Frederica, Delaware. From my note book I copy the case: Began treatment May 10th, 1859. First husband died of pulmonary consumption. Her sister has hæmorrhages from her lungs and her family has a phthisical history. She had previously taken cod-liver oil, which nauseated her stomach. Gave her fish, phosphoids and tonics, with glycerine. Her condition, which was very unfavorable at the beginning of treatment, gradually improved, and by the first of January, 1860, she seemed well, regained her strength and former weight. She afterwards became pregnant, gave birth to a live child and soon afterwards the disease returned. She then became a patient of my friend Dr. Albert Whitely, of Frederica, and died in a few months. Although this case finally succumbed, I think it proves the efficacy of the phosphoid preparation now known as protagon. I cannot predict what the result would have been in the fatal relapse if she had been given protagon, but I can see no reason why she would not have recovered.

My second case was Miss Ella Lewis, of the same town. This case came into my hands in the fall of 1859; it was one of acute

tuberculosis. I gave protagon, but it was without any obvious advantage. Soon after this I tried the protagon on Mrs. Jane Prettyman, of Milford, Delaware. She came into my hands well advanced in the second stage of tuberculosis, a large vomica in the left lung, very harrassing cough and muco-purulent expectoration, diarrhœa, night sweats, heetic fever, and both lungs badly infiltrated with tubercle. Placed her on protagon; she slowly improved and finally regained a comfortable but not restored stage of health. She became pregnant, gave birth to a child, which *I believe yet lives*, and afterwards relapsed, grew worse while taking protagon, and afterwards died, as the patient of Dr. Nathan Pratt, of Milford. This last case was too far advanced for cure, yet protagon no doubt extended her life at least three years, and at one time promised to make a final cure. Another case exhibited its virtues in a very positive manner. Joshua Willey, aged 27. His entire family tuberculous; father and mother died of phthisis, as also several brothers and sisters. After being pronounced by a physician beyond relief, came into my hands. I gave him protagon. Under its use, very rapidly improved and became sufficiently well to leave his bed and assist his wife in her domestic duties in three months after he began using it. While I was very proud of the result, and flattering myself of curing an advanced case of consumption, he went out in the snow in his stocking feet (his feet being yet a little swelled so as to interfere with putting on his boots) contracted pneumonia, and died from it. This was in 1860.

The civil war soon diverted my attention from brain phosphoids, but in 1864, while at St. Augustine (Florida) General Hospital, I formed a beautiful mixture of cerebric acid and the cerebrates, and gave it to several broken down cases in the hospital with prompt results. This preparation was further perfected by hospital steward Hanverman and constitutes to-day my favorite preparation, the glycerite of kephaline. This I am using with good results, but I prefer to leave the cases longer under observation ere I dare assert they are safe from a return of this generally fatal disease. Glycerite of kephaline contains phosphide of nitrogen, cerebric acid, cerebrate of calcium, cerebrate of ammonia, and cerebrate of potassium, with glycero hypophosphorous acid. It does not contain the phosphites, but phosphates and oleo hypophosphorous acid which are embodied in the preparation known as *Protagon.* With this glycerite of kephaline and the hypophosphite of oleine I

have found incipient phthisis usually curable; in the second stage a considerable per cent. will recover under their conjoined use, and in the third stage I have derived but little advantage from their use, preferring to rely on wine, quinia, wild cherry-bark, and sulphuric acid.

I believe, in using protagon or the glycerite of kephaline, it is important to isolate married women from their husbands. They rapidly invigorate the sexual apparatus of both sexes, and no doubt, will favor conception. While pregnancy may check the development of phthisis, lactation hastens it on with increased speed. The treatment in which the writer entertains the greatest confidence is plenty of rich, nourishing food, exercise in the open air, regulation of every habit of life and the restoration of the missing phosphoids. But it is useless to give phosphoids to a patient suffering from strumous dyspepsia. Butyric acid, it has been demonstrated, marks all the tests for phosphorous acid, and no doubt prevents their assimilation. It must be remedied ere we can derive any advantage from protagon or the glycerite of kephaline. Usually then, in addition to the alkaline tonic, the physician can employ a combination similar to this:

℞. Ol. morrh., Oj.
Emul. pancreat., ℥iv.
Propylamin, ℥iij.
M.

Sig: — Tablespoonful thrice daily before and after meals.

This combination usually exerts a very salutary impression upon the duodenal lesion, and prepares the system for the administration of the glycerite of kephaline. This point being attained, the tonic alkaline mixture may be discontinued; the above cod-liver oil emulsion taken before meals and two drops of the glycerite of kephaline after meals. I find it an excellent adjunct to the glycerite of kephaline to administer it simultaneously with extract of malt. I have a decided preference for the German malt extract made by Löflund. It has ever given me a high degree of satisfaction and I believe it deserves all the eulogy bestowed upon it by Liebig, Trousseau, Niemeyer, Aitken, Zeiseman and others.

Torpidity of the liver is a usual accompaniment of incipient tubercuIosis. For this condition, rheubarb, aloes and blue mass are excellent. Formerly I entertained the common prejudice against mercurials, but I am now confident they are not so injurious

in phthisis as was formerly supposed. Judiciously given, the benefit which will accrue far exceeds the injuries they entail.

As the disease advances, the physician will encounter the virus created in the caseous morphology of inflammatory product, and to combat this virus, I have usually found the best results by combining carbolic acid with the cod-liver oil emulsion. Salicine and quinia, with sulphurous acid, seem sometimes to be of especial value. Permanganate of potassium is a valuable antiseptic internally and externally, and often checks the hectic fever and night sweats which are usually but the consequence of this form of blood poisoning. Iron, denounced by Trousseau and applauded by others, has in my hands often been of advantage, especially in the advanced stages, when there is anæmia and decided debility. Perhaps the muriated tincture is the most usually advantageous; combined with dilute phosphoric acid (made from phosphorus) and sulphate of quinia, it forms an admirable tonic; some prefer the proto-carbonate, others give a preference for the scaled salts. A preparation I have used with advantage is syrup of the phosphates of iron, quinia and strychnia made by my modification of Easton's syrup. The formula is:

℞.	Recently precipitated phosphate of iron,	grs. 384.
	Pure quinia (alkaloid),	grs. 192.
	Strychniæ,	grs. vj.
	Syrupy phosphoric acid (S. G. 1.5).,	f. ʒxviij.
	Syrup, sufficient to make	f. ℥xxiv.

M.

Of this a drachm may be given thrice daily.

Manganese, especially the carbonate, and the syrups of the phosphates, is very often a valuable adjunct to the iron.

Complications:—Cough is usually the symptom which attracts the attention of the patient in the most impressive manner. The consumptive regards it as his especial and implacable foe, and upon it he centres his attention. He erroneously imagines that if he were free from the cough he would be entirely well; consequently it is difficult to manage his prejudices and anxieties. Unfortunately this unfortunate class of human sufferers almost always find in the almanacs and advertisements of the nostrum venders assurances of speedy relief. The consumptive's money and his life too often are the price of his credulity. He buys nauseating expectorants, embodying anodyne properties. He obtains temporary

relief and imagines that he has found the balm to heal his lungs. He uses bottle after bottle until his devitalized frame sinks upon the bed, to rise no more. Nearly all these quack expectorants are poisonous to the consumptive; they destroy the integrity of the digestive functions; aid in tubercular deposit, and hasten their victim to the grave. I have yet to find a single case which had used Jayne's Expectorant and was afterwards benefitted by any treatment.

As a rule, the consumptive would do better without any expectorant or cough medicine. Sometimes they are really useful but more often it is a *questionable piece of policy* to employ them.

A formula I have used with advantage is:

℞.	Syr. pruni virg.,	℥iij.
	Fl. ext. glycrrh.,	℥j.
	Mucil. acacia,	℥j.
	Potassii cyanidi,	grs. ij.
	Acidi citrici,	ʒss.
	Morphiæ acet.	grs. iij.
	Spt. etheris nit.,	℥j.
	Syrup sanguinaria,	℥ss.
	Ext. prunus virginian, q. s. ad.,	℥viij.

M.

Sig:—Dessert-spoonful thrice daily.

Although I do not recollect a single case in which I could impute any injurious consequences—I use this and all similar mixtures but seldom. Prof. Dacosta usually relies upon the following combination to relieve the cough:

℞.	Morphiæ acetat.,	grs. ij.
	Potassii cyanidi,	grs. j.
	Acidi acetici,	f ʒj.
	Ext. prunus virg. fluid; et mucil acaciæ, aa	℥ij.

M.

Sig:—Three or four times a day.

The formula used in the Brompton Hospital occasionally proves very satisfactory:

℞.	Morphiæ mur.,	grs. ss.
	Acid hydrocyanic, dil.,	m. xv.
	Acidi muriatici, dil.,	m. ijss.
	Oxymellis scillæ,	f ʒss.
	Aquæ., q. s. ad.,	℥j.

M.

Sig:—One or two spoonfuls as required.

I am now treating a case (August, 1871) in which I have used the above combinations in succession, without apparently modifying or relieving a very obstinate cough, but have received the most gratifying consequences with the following, which is but a slight modification of a favorite formula of Dr. Tanner:

R. Spts. ammonia arom; spt. chloroformi, ℥jaa.
Morphia acetatis, grs. j.
Potassii bromidi, ℥iij.
Extract cinchona, flav. fluid, ℥vj.
Elixir calisayæ, q. s. ad., ℥vj.

M.

Sig:—Dessert-spoonful in a wine-glassful of port wine (California) every four hours.

Night sweats are best relieved by sulphate of atropia, oxide of zinc and ext. of camomile—the proportions I usually employ are one-sixtieth of a grain of atropia, one grain of the oxide of zinc and four grains of the extract of camomile, in two pills, to be taken at one dose at bed-time, and if there be much associated debility, I give during the day the following astringent tonic, if the already adopted treatment does not arrest the night sweats:

R. Acidi gallici, ℈iv.
Acidi sulph. arom., ℥iss.
Sulph. quinæ, grs. xvi.
Fl. ext. hamamelis, ℥iv.
Curaexo cordial, q. s. ad., ℥viij.

M.

Sig:—Tablespoonful thrice daily.

I find however, that in the earlier stages at least that the glyerite of kephaline, ℥xij; tinc. iodine, ℥j; pure glycerine sufficient to make ℥viij. a teaspoonful given in dessert-spoonful doses of malt-extract, is about all the medicines my patients require. Too much medication is disastrous to the consumptive and often hastens the progress of lung disintegration, and the exact boundary between too much and too little is often nicely defined. If pneumonia, pleurisy or bronchitis supervene, they must be promptly combatted, but the fact of the presence of tubercle must not be overlooked. All depressing agents must be avoided and yet vascular excitement must be limited. Counter irritation with croton oil, and a combination of tonics and anodynes, have given me the most satisfaction. Carbonate of ammonia in brown mixture, in which ipecac is substituted for the antimonial wine, may be given

every six hours, and midway between the intervals one of the following pills:

℞. Pil. hydrarg., grs. vi.
Pulv. camphoræ, grs. xxiv.
Sulph. quiniæ, grs. xij.
Sulph. morphiæ, grs. j.
Div. in pill no. xii. M.
Sig:—One pill every six hours.

Diarrhœa, a common and often serious complication, presents itself under different phases, sometimes being but an expressing of reflex irritation from a torpid liver, and defying the entire parapharnalia of opiates and astringents; sometimes a consequence of butyric fermentation, and in others depending upon tubercular ulceration. The first class is best relieved by blue pills, aloes and rheubarb; the second class by emulsion of pancreatine with alkalies and tonics; and the third by nitrate of copper and opium; solution of the ter. nitrate of iron; bismuth, pepsin and strychnia in combination; and vegetable astringents.

Hæmorrhage is a complication which always excites alarm. If not very profuse, I merely let my patients eat chloride of sodium, but if this is not adequate to its control, and threatens to to be dangerous, I find five grains of plumbic acetate and one-half grain of opium, given every one or two hours, or four hours, the most efficient anti-hæmoptisic remedy I have ever employed. A somewhat poly-pharmaceutical combination modeled after, and very similar to Dobell's favorite formula, is:

℞. Tinct. digitalis, ʒii.
Fluid ext. ergotæ, ʒij.
Acidi gallici, ʒj.
Fl. ext. matico, ʒij.
Magnesiæ sulph., ʒiv.
Acidi sulph. arom., ʒjss.
Infusion hamamelis, virg., q. s. ad. ℥viij.
M.

Sig:—Two tablespoonfuls every three hours until the hæmorrhage is controlled.

In some cases in which there was extensive tubercular infiltration, I have used iodide of calcium in combination with the glycerite of kephaline with the happiest results. Within the past six months I have treated Mrs. J., within three squares of my office,

with her left lung badly infiltrated and her menses arrested. With malt, iodide of calcium and glycerite of kephaline, her menses have become established, her cough has ceased, and with the exception of remaining dulness and modified respiration she seems to be in the enjoyment of perfect health.

I submit these theories, deductions and results to the candid examination of the medical profession, conscious that if I am not mistaken in my observations, that the application of the phosphoid constituents of the brain of animals and of wheat will prove of more value in tubercular disease than any remedy heretofore known.

No. 176 Bridge Street, (Bridesburg)

August 24th, 1871. Philadelphia.

NOTE:—The preceding pages, written during the summer of 1871, are part of a paper presented to the editor of the *American Journal of Medical Sciences* and considered by him not sufficiently well authenticated to occupy sixty pages of his Journal. All subsequent researches however, have contributed to establish theories of mine which were formerly considered vague delusions of an enthusiastic and impractical mind. A year after this manuscript was presented, Dr. S. R. Percy produced a prize essay on phosphorus, for the American Medical Association, confirming some of the chemical and pharmaceutical opinions here declared. He then gave his experience with an oleo hypophosphite which he formed by mixing lard oil, beef juice and phosphorous, and passing a current of dry oxygen through it until there was no evidence of free phosphorus—which he claims is identical with protagon. This is an error; it chemically and therapeutically corresponds with the oleo hypophosphorous acid of the brain. This compound he reports to have used in various diseases with good results, but does not seem to have tried it in tubercular disease. The remedy I produced in 1873, made by mixing oleic acid with glycerine, saturating with phosphorous and decomposing with the bin-oxide of nitrogen, is superior as a remedial agent to that proposed by Dr. Percy. A French chemist had however, as early as 1862 made oleo hypophosphorous acid so-called, but I am not sure that we have hypophosphorous acid until the compound is brought in contact with water, when it is unquestionably present. I am inclined to

the opinion that previously it is in the formula of an oleo nitrogenous phosphide. At any rate it is a very efficient remedial agent. In 1873 I formed a preparation called wine of wheat, which I have used with excellent results in diseases of dentition, infantile phthisis and tabes mesenterica—made by beating wheat to a pulp, macerating with alcohol, precipitating and redissolving by port wine and dilute phosphoric acid. I imagine this is about identical, in its therapeutical and chemical phosphates, with the so-called vitalized phosphates, introduced by Dr. Percy about the same time, I am informed, although I was not aware of the remedy until March, 1877, when Mr. A. C. Dung sent me a circular.

In November, 1876, I published an article on "Protagon" in "New Remedies." It awakened intense interest and since then I am cognizant of the manufacture and sale of a thousand pounds.

I have letters from over two hundred physicians. Those who used it in advanced stages realized but little benefit; those who tried it before there was extensive lung disintegration speak of the result in satisfactoy terms; and those who used it in the early stages declare it a specific. My treatment at present is glycerite of kephaline, ʒxii; tinct. iodine, ʒj; pure glycerine sufficient to make eight ounces—dose, teaspoonful thrice daily in Löflund's extract of malt. Trommer's is said to be equally good but I have no personal experience with it.

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